Claims

1. (Currently amended) A method of recovering a three-dimensional scene from two-dimensional images, the method comprising:

providing a sequence of ~~images~~ frames;

dividing the sequence of ~~images~~ frames into frame segments wherein the frames in the sequence comprise feature points and wherein dividing the sequence of frames into frame segments is based upon at least a threshold number of feature points being tracked between the frames of the frame segments;

performing three-dimensional reconstruction individually for each frame segment derived by dividing the sequence of frames ~~individually~~; and

combining the three-dimensional reconstructed segments together to recover a three-dimensional scene for the sequence of images.

2. (Currently amended) The method of claim 1 wherein performing includes creating at least two virtual key frames for each of the segments, wherein the virtual key frames are only a subset of the images in a segment but are a representation of all of the images in that segment.

3. (Canceled)

4. (Original) The method of claim 1 wherein performing further includes:

performing a two-frame structure-from-motion algorithm to create a plurality of local models for each segment; and

combining the plurality of local models by eliminating scale ambiguity.

5. (Original) The method of claim 4 further comprising:

bundle adjusting the combined local models to obtain a partial three-dimensional model for each segment;

extracting virtual key frames from the partial three-dimensional model, wherein the virtual key frames include three-dimensional coordinates for the images and an associated uncertainty; and

bundle adjusting all segments to obtain a complete three-dimensional model.

6. (Original) The method of claim 1 further including:

identifying feature points in the images;

estimating three-dimensional coordinates of the feature points; and

estimating a camera rotation and translation for a camera that captured the sequence of images.

7. (Original) The method of claim 1 wherein combining includes performing a non-linear minimization process across the different segments through bundle adjustment.

8. (Original) A computer-readable medium having computer-executable instructions for performing the method recited in claim 1.

9. (Original) A method of recovering a three-dimensional scene from two-dimensional images, the method comprising:

identifying a sequence of two-dimensional frames that include two-dimensional images;

dividing the sequence of frames into segments, wherein a segment includes a plurality of frames;

for each segment, encoding the frames in the segment into at least two virtual frames that include a three-dimensional structure for the segment and an uncertainty associated with the segment.

10. (Original) The method of claim 9 wherein dividing includes:

identifying a base frame;

identifying feature points in the base frame; and

defining the segments such that every frame in a segment has at least a predetermined percentage of feature points identified in the base frame.

11. (Original) The method of claim 9 wherein the segments vary in length and wherein the length is associated with the number of frames in the segment.

12. (Original) The method of claim 9 further including:

identifying feature points in the sequence of two-dimensional frames;

estimating three-dimensional coordinates for the feature points; and

estimating camera rotation and translation for the feature points.

13. (Original) The method of claim 12 wherein estimating the three-dimensional coordinates includes applying a two-frame structure-from-motion algorithm to the sequence of two-dimensional frames.

14. (Original) The method of claim 9 further including:

dividing a segment into multiple frame pairs;

applying a two-frame structure-from-motion algorithm to the multiple frame pairs to create a plurality of local models; and

scaling the local models so that they are on a similar coordinate system.

15. (Original) The method of claim 14 wherein each of the multiple frame pairs includes a common base frame and one other frame in the segment.

16. (Original) The method of claim 15 further including interpolating frames between the multiple frame pairs.

17. (Original) The method of claim 9 wherein encoding includes:

choosing at least two frames in the segment that are at least a threshold number of frames apart;

for each of the at least two chosen frames, projecting a plurality of three-dimensional points into a corresponding virtual frame; and

for each of the at least two chosen frames, projecting an uncertainty into the corresponding virtual frame.

18. (Original) The method of claim 9 further including bundle adjusting the virtual frames from the segments to create a three-dimensional reconstruction.

19. (Original) The method of claim 9 further including identifying feature points in the frames by using motion estimation.

20. (Original) The method of claim 19 wherein the motion estimation includes:

creating a template block in a first frame including a feature point and neighboring pixels adjacent the feature point;

creating a search window used in a second frame; and

comparing an intensity difference between the search window and the template block to locate the feature point in the second frame.

21. (Original) The method of claim 9 wherein at most two virtual frames are used.

22. (Original) A computer-readable medium having computer-executable instructions for performing the method recited in claim 9.

23. (Currently Amended) A method of recovering a three-dimensional scene from a sequence of two-dimensional frames, comprising:

(a) ~~segmenting the~~ identifying at least a first base frame in a sequence of two-dimensional frames;

(b) adding the at least first base frame to create a first segment of the sequence;

~~(b)~~ (c) identifying feature points in at least [a] the first base frame in [a] the first segment;

~~(c)~~ (d) analyzing a ~~second~~ next frame in the ~~segment~~ sequence to identify the feature points in the ~~second~~ next frame;

~~(d)~~ (e) determining whether a threshold number of feature points from the base frame are identified in the ~~second~~ next frame;

~~(e)~~ (f) if a threshold number of feature points are identified in the ~~second~~ next frame, adding the ~~second~~ next frame to the first segment; and

~~(f)~~ (g) repeating ~~(c)~~ (d) through ~~(e)~~ (f) for subsequent frames until the number of feature points in a frame falls below the threshold number.

24. (Currently amended) The method of claim 23 further including designating [a] the next frame that falls below the threshold number as a second base frame in a second segment ~~and repeating (b) through (e) for the second segment~~.

25. (Original) The method of claim 23 further including performing motion estimation to identify the feature points.

26. (Original) The method of claim 23 further including using corners as the feature points.

27. (Currently amended) The method of claim 23 wherein the number of frames comprising a segment varies between segments.

28. (Original) The method of claim 23 further including creating two virtual key frames per segment.

29. (Original) The method of claim 28 further including bundle adjusting the virtual key frames of all the segments to obtain a three-dimensional reconstruction.

30. (Original) A computer-readable medium having computer-executable instructions for performing the method recited in claim 23.

31. (Previously presented) In a method of recovering a three-dimensional scene from a sequence of two-dimensional frames, an improvement comprising dividing a long sequence of frames into segments and reducing the number of frames in each segment by representing the segments using between two and five representative frames per segment, wherein the representative frames are used to recover the three-dimensional scene and remaining frames are discarded so that the three-dimensional scene is effectively compressed.

32. (Original) The method of claim 31 wherein each of the representative frames have an uncertainty associated therewith.

33. (Original) The method of claim 31 wherein the long sequence includes over 75 frames.

34. (Original) The method of claim 31 wherein dividing the long sequence into segments includes identifying a base frame and tracking feature points between frames in the sequence and the base frame and ending a segment whenever a frame does not contain a predetermined threshold of feature points that are contained in the base frame.

35. (Original) The method of claim 31 further including performing a two-frame structure-from-motion algorithm on each of the segments to create a partial model.

36. (Previously presented) A computer-readable medium having computer-executable instructions for performing a method comprising:

providing a sequence of two-dimensional frames;

dividing the sequence into segments;

calculating a partial model for each segment that includes three-dimensional coordinates and camera pose for features within the frames;

extracting virtual key frames from each partial model, the virtual key frames having three-dimensional coordinates for the frames and an uncertainty associated with the frames; and

bundle adjusting the virtual key frames to obtain a complete three-dimensional reconstruction of the two-dimensional frames.

37. (Previously presented) An apparatus for recovering a three-dimensional scene from a sequence of two-dimensional frames by segmenting the frames, comprising:

means for capturing two-dimensional images;

means for dividing the sequence into segments;

means for calculating a partial model for each segment that includes three-dimensional coordinates and camera pose for features within the frames;

means for extracting virtual key frames from each partial model; and

means for bundle adjusting the virtual key frames to obtain a complete three-dimensional reconstruction of the two-dimensional frames.